



necessary, without disturbing the rest of the chamber.

The gas mixture for the tests consisted of 20% isobutane, 80% argon and 0.1% freon, which gave an efficiency better than 99% over the voltage range of 2.7 to 3 kV and was completely uniform over the whole 17 m² area.

Four hexagonal 12 m² chambers will be installed for the neutrino experiment of the CERN / Dortmund / Heidelberg / Saclay collaboration. A tank filled with hydrogen or deuterium is to be added in front of the existing detector, to allow the interactions of neutrinos and antineutrinos with protons and neutrons to be studied separately, and the chambers will determine the point of interaction in the tank.

Each chamber consists of three layers of 1232 20 µm wires, spaced at 3 mm, and oriented in three directions with an angle of 120° between them. The read-out wires are fitted between two graphited Hostaphan planes at high voltage. A spacing of 10 mm between the anode and cathode planes is maintained by a Kapton concertina strip system. The electronics are the same as for the 17 m² chamber. The efficiency in the three elements of the first chamber, using a gas mixture of 20% isobutane and 80% argon, is over 98% with a voltage of between 3.5 and 3.9 kV.

A large quantity of ancillary equipment is needed for the construction of these very large chambers, because of their exceptional size and weight. It includes a wire-weaving loom, a loom for tensioning the Mylar planes, an automatic wire welding machine, a spray-painting booth, handling devices, etc. One of the last, but certainly not least, knotty problems to be solved will be that of transport to CERN. Saclay has already acquired some experience in this field with the transport of the twenty drift chambers already installed for the neutrino experiment.

Neutrons against cancer

The Cancer Therapy Facility at Fermilab treated its first patient a year ago (7 September 1976). Since then a total of 86 patients have completed the prescribed course of radiation and, overall, the results have been very satisfactory.

The Facility draws a neutron beam from a beryllium target bombarded by 66 MeV protons from the linac of the 500 GeV synchrotron. It has been used for biomedical experiments, as well as for cancer treatments, mainly aiming to determine parameters of neutron radiation which are important for therapy and for comparisons with other forms of radiation.

It has been gratifying that, with the patients treated so far, the use of neutron beams as the sole method of treatment was very successful in controlling radiation resistant tumours. Side effects have been mild.

Encouraged by this experience, the National Cancer Institute has extended the research grant for the CTF for a further three years and its budget has been trebled. This will enable the number of patients treated per day to be increased and will also enable the fundamental questions about the efficacy of neutron radiation to be answered more quickly.

The Medical Research Council Cyclotron Unit at Western General Hospital, Edinburgh was officially opened on 27 September. It houses a cyclotron for the production of neutron beams for cancer treatment.

Two neutron beams are produced by the cyclotron and a special feature is that one of them is steerable. The compact cyclotron, manufactured by The Cyclotron Corporation, provides 100 µA of deuterons at 15 MeV. A switching magnet enables the output beam to be directed onto a fixed target or an isocentric target to give the manoeuvrable beam.

The considerable clinical experience in the use of neutron beams for cancer therapy at the Hammersmith Hospital, London, was of great value in the design of the new unit. The first

The full scale prototype of the 17 m² proportional chamber built at Saclay for an experiment at the CERN SPS. On the right is the first of four hexagonal proportional chambers which are to be installed as vertex detectors in the WA1 neutrino counter experiment at the SPS.

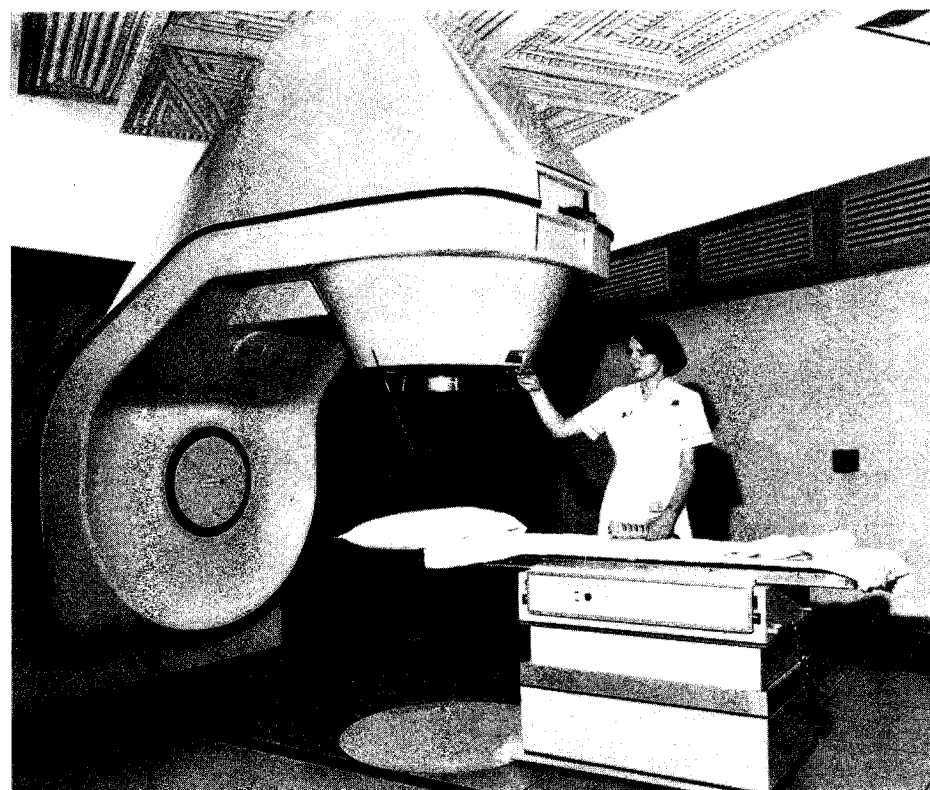
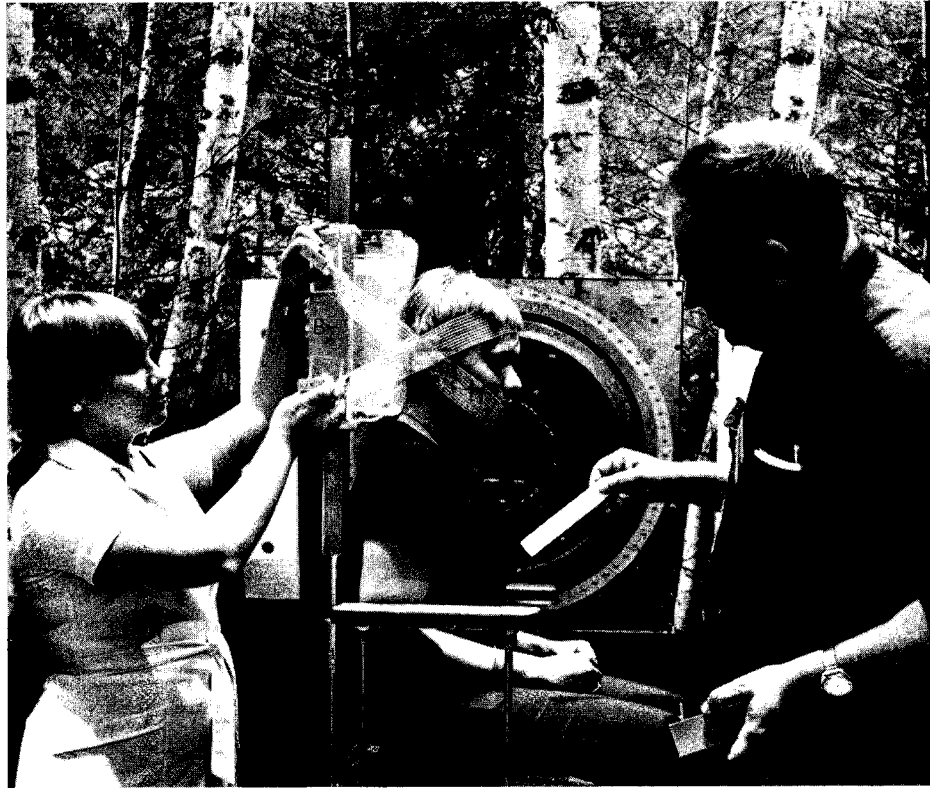
(Photo Saclay)

patients were treated in March of this year and some 70 patients have now completed their treatment. All have received neutrons from the fixed beam up to now and the steerable beam is scheduled to be in operation in a few months' time.

A team of biologists (Frank Ngo, Antun Han, Hiroshi Utsumi and Mortimer Elkind) from the Biological and Medical Research Division at Argonne are carrying out a detailed study of the relative effects of neutron irradiation and conventional X-ray and cobalt-60 gamma rays on cancerous cells.

They have access to three neutron sources in the Chicago area each covering a different energy spectrum. These are — the JANUS reactor at Argonne, the cyclotron at the Franklin McLean Institute of Chicago University and the Cancer Therapy Facility at Fermilab.

The results so far show that smaller doses of neutrons than X-rays are needed to kill equal numbers of cells. As the neutron energy increases (from reactor energies to CTF energies) the dose needed increases. Neutrons are more effective in killing the oxygen starved, radiation resistant cells often found in tumours. Also the cells are less able to repair damage after neutron irradiation.



1. The preparation of a patient for treatment at the Cancer Therapy Facility at Fermilab in front of the beam-line which brings neutrons from the linac.

(Photo Fermilab)

2. The isocentric neutron beam equipment at the Cyclotron Unit of Western General Hospital in Edinburgh.

(Photo John Porteus)